

No. 4. — *The fossil cetacean, Dorudon serratus* GIBBES.

By FREDERICK W. TRUE.

SOME months ago the authorities of the Museum of Comparative Zoölogy very generously placed in my hands for study the type specimens of the fossil cetacean, *Dorudon serratus*, which was originally described by Dr. R. W. Gibbes in 1845. The material was without any other label than the following: — “This entire lot belongs to the R. W. Gibbes collection, marked ‘Eocene’ (no locality), but probably South Carolina.” A glance at the specimens, however, satisfied me that they included the types of *Dorudon serratus*, and this was confirmed by reference to the original description and figures in the Proceedings of the Academy of Natural Sciences of Philadelphia, 1845, Vol. 2, page 254–256, Plate 1.

The type specimens themselves consist of (*a*) a fragment of the right maxilla, containing three molar teeth nearly complete, (*b*) an upper premolar with a fragment of the maxilla attached, in which is a second alveolus, and (*c*) an incisor or canine tooth. These were figured, as above mentioned, in 1845. Associated with the types by Gibbes, and contained in the lot of material now at hand, are (*d*) the left half of a mandible, nearly complete, but with the condyle missing, some of the teeth crushed and without crowns, and others lacking altogether; and (*e*) a small fragment from the right side of a mandible, to which is attached a canine or incisor tooth with a broken crown. These specimens were figured by Gibbes in a second article (Journal of the Academy Natural Sciences of Philadelphia, 1847, series 2, Vol. 1, pages 1–15, Plate 3, figures 1–2).

In this latter article Gibbes figured (Plate 3, figures 5–6) also another fragment which is in the collection, namely, (*f*) a portion of a left premaxilla. He also mentioned (*g*) a fragment of a right premaxilla which is present, and (*h*) figured (*op. cit.*, Plate 2, figure 1, two views, unnumbered) an incisor or canine tooth, which has likewise been preserved.

In addition to the foregoing, the collection contains the following: — (*i*) The zygomatic process of the left squamosal, incomplete; (*j*) a portion of the right parietal; (*k*) the orbital plate of the right frontal,

nearly complete; (*l*) the right and left nasals, nearly complete; (*m*) a portion of the petrosal?; (*n*) a portion of the right ramus of the mandible; (*o*) several fragments of teeth; (*p*) part of an atlas; and (*q*) portions of three ribs.

The history of the genus *Dorudon* has been summarized by Müller, Carus, Leidy, Hay, and others, and it will be unnecessary for me to do more in the present connection than refer to the principal views which have been held regarding it. A list of references will be found in Hay's Bibliography of Fossil Vertebrata of North America, 1902, page 587.

In the original description, in 1845, Gibbes mentioned that the type-specimen was found "in a bed of green sand near the Santee Canal, in South Carolina. The locality is on the plantation of R. W. Mazyck, Esq., about three miles from the entrance of the canal from the head waters of the Cooper River . . . I visited the locality where it was found, but the marling operations of the planters had ceased for the season, and the pits were filled with water. I have made arrangements for excavations in the fall, when I hope to procure other bones of this remarkable fossil" (Proceedings of the Academy of Natural Sciences of Philadelphia, 1845, Vol. 2, pages 254-255). In his second article Gibbes remarked: "During an extensive exploration of the bed of green sand at the locality [where the type was found], with the hope of turning up other portions of the skeleton, fragments of a lower maxilla containing the then unfigured tusk were procured, with twelve caudal vertebrae." (Journal of the Academy of National Sciences of Philadelphia, 1847, series 2, Vol. 1, page 10).

In this second article Gibbes, influenced by the opinion of Owen (Proceedings of the Academy of Natural Sciences of Philadelphia, 1846, Vol. 3, page 15), abandoned his genus *Dorudon*, placing the species *serratus* in the genus *Zeuglodon*, or *Basilosaurus*. In 1848 Agassiz (Proceedings of the Academy of Natural Sciences of Philadelphia, 1848, Vol. 4, page 4) expressed the belief that *Dorudon* was distinct, but the characters which he assigned to it are not intelligible. Leidy in 1869 (Journal of the Academy of Natural Sciences of Philadelphia, 1869, series 2, Vol. 7, page 428, Plate 29, figures 2-5) also accepted *Dorudon*, and gave a list of synonyms of *D. serratus*, among which are included *Zeuglodon brachyspondylus* Müller, and *Z. hydrarchus* Carus, both based on the same specimen. He remarks, however, that it is by no means certain that *serratus* and *brachyspondylus* are the same. In this connection Leidy published some figures of teeth from the Eocene of Alabama, which he regarded as belonging to *Dorudon*.

Cope in 1890 remarked: — “When the *Z. brachyspondylus* Müll. is better known it may be found to be referable to a distinct genus, *Doryodon Gibbes*” (American Naturalist, 1890, Vol. 24, page 602).

Dames in 1894 states that he cannot agree with Leidy in regarding *Zeuglodon brachyspondylus* as a synonym of *Dorudon serratus*, and affirms that the latter is easily distinguished from *Z. brachyspondylus* or *Z. macrospondylus* (= *Basilosaurus cetoides*) by the form of the teeth.¹ His remarks on this point are as follows: — “The straight, high, and pointed accessory cusps, which are very large as compared with the principal cusp, suffice to distinguish the tooth-crowns of *Dorudon serratus* from those of the *Zeuglodons* from Alabama; in addition, the roots, both branches of which are always nearly parallel in the latter, in *Dorudon* diverge at an angle of about 80° . . . Whether one proceeds more properly in keeping *Zeuglodon* and *Dorudon* separate as genera, or in treating *D. serratus* as a separate species of *Zeuglodon*, is uncertain. I should incline to the first course.”

In the following pages I shall endeavor to explain my own view, which nearly coincides with that of Dames, and is that the genus *Dorudon* is distinct from *Basilosaurus*, and that the species which Müller mentioned as a small form of his *brachyspondylus*² is allied to the former but represents a distinct genus.

It is somewhat remarkable that Gibbes did not mention more than a part of the specimens which were sent me from the Museum of Comparative Zoölogy as belonging to the “Gibbes collection.” One can only

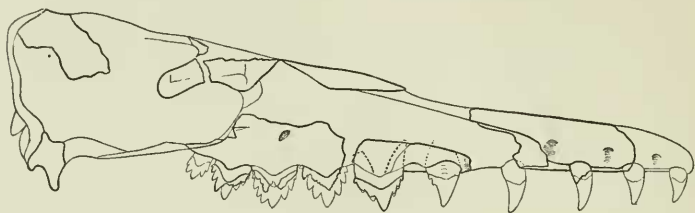
¹ Pal. Abh., 1894, (2), Bd. 1, Heft 5, p. 16. He also corrects the erroneous statement of Zittel (Handbuch Pal. Vert., 1893, p. 168) that *Dorudon* is based on vertebrae of *Z. brachyspondylus*.

² The confusion between the large form of zeuglodont with short lumbar vertebrae and the small form of zeuglodont with short lumbar vertebrae in Müller's work is very puzzling. The latter is sometimes referred to by him merely as *Z. brachyspondylus*, and sometimes as “der kleine Zeuglodon.” He was in doubt as to this small form, as shown by his remark on p. 29: “Whether the small *Zeuglodon* is a separate species . . . or the young of *Zeuglodon brachyspondylus* is still uncertain at present.”

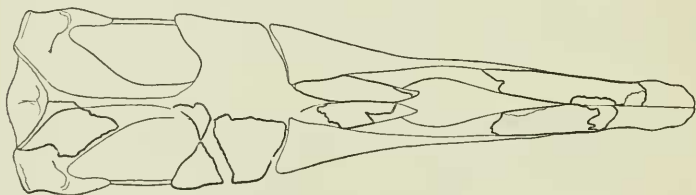
In the appendix to his work (p. 31), however, he describes the small skull now in the Teyler Museum, Haarlem, as “a small individual of *Zeuglodon brachyspondylus*.” This would be satisfactory if it were not that he also describes the large, short lumbar vertebrae on page 26 under the same name.

Recognizing this difficulty, Von Stromer in 1903 (Mitth. Pal. und Geol. Inst. Univ. Wien, 15, p. 85), limits the name *brachyspondylus* to the form represented by large, short lumbar, and assigns the name *brachyspondylus minor* to the small species with short lumbar. This nomenclature is accepted in the present paper.

conjecture that he received some of them after the publication of his two articles, or that he did not recognize them as belonging to *Dorudon*. There is, indeed, no proof that they all represent that genus, but after



examining them I am of the opinion that, with the possible exception of the ribs, they all belong to *Dorudon serratus*, and probably to the same individual. I base this opinion on the fact that they are all of one color and are all filled with a green sand of uniform texture and color, and that the size of the different parts appears to be properly proportional. In order to bring the evidence as regards size clearly before the reader, I have made a restoration of the skull, in outline, which is represented in figures 1 and 2, one-eighth natural size. The parts actually present in the Gibbes collection are indicated by heavy lines, and among them will



be recognized those figured by Gibbes in 1845 and 1847. All these parts are represented in Plates 1, 2, and 3, which are reproduced from photographs.

Gibbes recognized the fragment of the maxilla containing three teeth to be such in 1845, but in 1847 he described and figured it, together with the premaxilla, as a part of the mandible. The right premaxilla contains the third incisor and a part of the alveolus of the second. The first incisor and the adjoining parts of the premaxilla are lacking, and are restored in figures 1 and 2. Both premaxillae show the large concavity in which the anterior end of the maxilla rests, but the nasal branch above it is broken off, and is restored in the figures. The length

of the latter depends, of course, on the length of the anterior extension of the maxilla which articulates with the premaxilla. As this is lacking in part, the length of the nasal branch of the premaxilla is uncertain, as are also the exact proportions of this region of the skull.

The left nasal bone is nearly complete, and of the right about one-half remains. It is possible, therefore, to show quite exactly the shape and relative position of these bones. The outer margin is divided unsymmetrically into two parts, of which the posterior is the shorter. This shorter margin appears to articulate with the maxilla, and the longer margin with the premaxilla. The two nasals fit together accurately in the middle, the right one having a superior ledge which lies on an inferior ledge of the left nasal. The median line of junction is somewhat sinuous. The nasals in transverse section are strongly curved, and when joined together in the natural position, form a vaulted roof over the nasal cavity. At the posterior end the inferior surface is marked with coarse, longitudinal sutural ridges.

The detached fragment containing a single tooth, which Gibbes figured in 1847 in his Plate 4, figure 4 (see Plate 1, figure 4, accompanying this article), is very important and at the same time rather difficult to interpret. Accompanying the fragment is another of similar size which fits against the root of the tooth and contains the alveolus of a second tooth. After closely studying the tooth which is present, I am of the opinion that the other alveolus belongs in front of it and is that of the first premolar. Anterior to this alveolus is a small, conical piece of bone, which represents the anterior end of the maxilla, so far as it is preserved, but how much is lacking is uncertain, as is also the position of the canine, of which no trace remains. That there was another premolar tooth anterior to the alveolus above mentioned is improbable. That the fragment containing the tooth is from the anterior part of the maxilla, and that the tooth is, therefore, a premolar, is evident from the fact that its external surface is nearly flat, while in the fragment with three teeth, presently to be mentioned (which bears the articulation for the malar at the posterior end and is therefore the posterior part of the maxilla), the external surface is quite convex. The anterior and posterior margins of the crown of the premolar tooth are, I believe, distinguishable, owing to the fact that in all the teeth of *Zeuglodon* and its allies, as shown by specimens in the National Museum and by the figures of Müller, Andrews, and other authors, the accessory cusps are smaller and further from the apex of the tooth on the anterior margin than on the posterior.

The inferior surface of the maxillary fragment containing PM^2 and the alveolus of PM^1 , just mentioned, is apparently complete, and indicates that the palate, and hence the rostrum also, was quite narrow behind the canines, although the posterior extension of the palatal branch of the premaxillae may have added a little to the breadth. This fragment is from the left side, while the piece of the maxilla containing three teeth is from the right side. Hence, it is not possible to determine positively whether, when the former is transposed to the right side, as has been done in figure 1, the two pieces should be contiguous, or whether space for another tooth should be left between them. I am of the opinion that they should be contiguous.

The fragment containing three teeth (Plate 1, figure 2) is one of Gibbes's types and was well figured by him in 1845 (Proceedings of the Academy of Natural Sciences of Philadelphia, 1845, Vol. 2, Plate 1, figure 4) and 1847 (Journal of the Academy of Natural Sciences of Philadelphia, 1847, series 2, Vol. 1, Plate 4, figure 1), though reversed, and in 1847, at least, considered as belonging to the mandible. Beside the three teeth it has, at the posterior end, a concavity which represents the outer wall of the alveolus of a tooth about half the size of the others. This was probably the last molar (M^2). The three large teeth are all somewhat broken, but enough of them remains to indicate their original form and size. A very small fragment of the palatal surface of the maxilla remains attached to the second of these teeth near its anterior root. It is concave and presents a small depression which may mark the position of the apex of one of the mandibular teeth. As already mentioned, the fragment bears at the posterior end a short, triangular process, flat on top, intended to receive the anterior end of the malar bone. A small piece only appears to be lacking from the process. The outer surface of the maxilla above the three large teeth is convex, and there is a depression above the second tooth (PM^4) which appears to represent the ante-orbital foramen. Above the third tooth (M^1) a short, narrow, triangular ridge is developed. This ridge appears to be nearly complete, and its free end is probably about in line with the posterior margin of the maxilla, or, in other words, the anterior margin of the orbit. The shape of the maxilla above the three large teeth (PM^3 , PM^4 , and M^1) and of the ridge just mentioned is characteristic of *Dorudon*, and distinguishes it from *Zeuglodon brachyspondylus*, but *Prozeuglodon* appears to have a similar conformation.

The original height of this posterior portion of the maxilla cannot be determined accurately, but from the small angle between the superior

and inferior surfaces of the premaxillae and the rather small orbit, one may infer that it was not great.

The frontal is represented only by the right orbital plate (Plate 2, figure 2), which is in three pieces. These pieces cannot be fitted together, but the shape of the arch of the orbit indicates that the outer free margin is complete, or nearly so. Anterior to the orbit is a triangular prolongation, on a slightly lower level than the top of the orbit itself, and having the surface somewhat different in texture. It is possible that this triangular area was overlapped by the posterior thin end of the maxilla.

Behind the frontal no part of the upper surface of the skull is preserved, except a portion of the right parietal bone (Plate 2, figure 3). This, fortunately, is complete in the median line and posteriorly, and indicates the form of the occipital and sagittal crests. The distance between the vertex and the nasals can, however, only be estimated.

A small piece of the squamosal (Plate 2 figure 4) from the left side indicates the shape of the zygomatic process and the position of the external auditory meatus. The occipital condyles are lacking, and nothing can be determined regarding the inferior surface of the skull except as above mentioned.

The teeth merit a special description. As already stated, the first upper incisor is lacking on both sides, the premaxillae being incomplete anteriorly. A portion of the alveolus of the second upper incisor is present on the left side. When complete, it measured about 22 mm. in diameter longitudinally. The distance between it and the alveolus of the third incisor is 29 mm. The longitudinal diameter of the latter alveolus is 25 mm., and of the third incisor itself, measured on a level with the top of the alveolus, 21 mm. The transverse diameter of the tooth at the same point is 15 mm. As indicated by these measurements, the root of the tooth is elliptical in section at its junction with the crown. Only a small portion of the latter remains, but sufficient to show that the enamel was strongly rugose, and that a well-defined, narrow ridge extended from the base of the crown probably to the apex posteriorly.

The alveoli of the upper incisors are connected by a narrow groove. The palatal surface of each premaxilla internal to this groove is flat, and is divided longitudinally in the centre by another groove, running parallel with the median border. In front of and behind the third incisor the outer surface of the premaxilla is strongly compressed. In front of the tooth, at a height of about 22 mm. above the palatal surface, is a circular concavity, representing the position of the apex of the lower

third incisor when the mouth was shut. A similar concavity behind the tooth, about 28 mm. above the palatal surface, indicates the position of the apex of the lower canine. That it is higher up than the preceding concavity shows that the canine is longer than the third incisor in this species.

Following the third upper incisor, there is a deep concavity in the premaxilla, in which the anterior end of the maxilla rested. The latter bone is broken anteriorly, and hence nothing can be determined regarding the form, or exact position, of the canine. The most anterior portion of the maxilla preserved contains, as already mentioned, the alveolus of a large tooth, which was presumably the first upper premolar, and following it a still larger tooth in its socket which I consider the second premolar. The alveolus of the first premolar is pyriform, and has a longitudinal diameter of 39 mm. and a transverse diameter of 21 mm. Immediately in front of it, where the bone is broken off, is a concavity not less than 18 mm. deep, and inclined inward and backward, which I was at first disposed to regard as the anterior root of the first premolar. After close examination I am of the opinion that it represents the impression of the apex of the first lower premolar. The bottom of it lies a little outside the line of the long axis of the large alveolus which succeeds it.

The first upper premolar was probably a single-rooted tooth, as the alveolar cavity narrows rapidly upward. The distance between this tooth and the second upper premolar is 16 mm. In the interval between the two teeth and a little within the line of the long axis of the former is a rather shallow concavity, which represents the impression of the apex of the second lower premolar.

The second upper premolar of the left side, a two-rooted tooth, has the following dimensions (Plate 1, figure 4): Depth from apex of crown to end of anterior root,¹ 71 mm.; to end of posterior root,¹ 71; breadth of crown at base, 52; length of anterior edge of principal cusp, 22; length of posterior edge of the same, 19; antero-posterior breadth of the anterior root, on the line of anterior base of the crown, 20; antero-posterior breadth of posterior root, on line of posterior base of crown, 25; transverse breadth of the anterior root at the same point, 14; transverse breadth of the posterior root at the same point, 15; distance between the apex of the principal cusp and the point of junction of the two roots, 34.

The greatest height of the enamel at the middle of the crown as pre-

¹ Slightly broken.

served is 27 mm., but there are sundry dark spots and rough points on the roots which appear to indicate that the crown was originally somewhat deeper, perhaps as much as 40 mm. all together at the middle on the inner face and 36 mm. on the outer face. This would change the shape of the crown materially and bring it much nearer the margin of the maxillary bones than is indicated in Plate 1, figures 2 and 4. However it may be with this premolar, the crown of the molars is certainly much less deep than in *Basilosaurus*.

The second premolar has three accessory cusps both anteriorly and posteriorly, the former smaller than the latter and further removed from the apex of the principal cusp. The free border of the anterior cusp adjoining the basal one bears a thin, sharp ridge, which is also apparent on the cusp next above. The anterior and posterior edges of the principal cusp are sharp, the former most so. The internal and external surfaces of the crown are convex, and the enamel, although everywhere somewhat rugose vertically, is conspicuously so only on the internal surface near the base of the crown. The roots are hollow, as mentioned by Gibbes.

Whether the three teeth (Plate 1, figure 2) which form part of Gibbes's types immediately follow the premolar tooth just described cannot be positively determined, but it is probable that they do; and they are, therefore, the third and fourth premolars and the first molar.

The third premolar is a somewhat smaller tooth than the second, with the two roots less divergent. The crown is badly broken, only the penultimate posterior accessory cusp remaining intact. Nearly all of the internal half of the tooth is lacking, but its shape is indicated by the green sand with which it was filled. The length of the posterior root from its junction with the anterior root is 43 mm., but was originally somewhat longer. The antero-posterior breadth of the crown is about 49 mm., and of the anterior root at its junction with the crown, 17 mm. The transverse diameter of the root at the same point was originally about 12 mm. The distance from the margin of the maxilla to the crown at the middle is 11 mm. The small portion of the enamel which remains is nearly smooth. The free margin of the penultimate posterior accessory cusp bears a sharp, thin ridge.

The fourth premolar follows the third with scarcely more than one or two millimeters intervening. Its anterior root, however, is a little external to the posterior root of the third premolar, and the form of the tooth is quite different. The anterior root at its junction with the crown has an antero-posterior diameter of 21 mm. and a transverse diameter

(maximum) of 11 mm., while the posterior root has the same antero-posterior diameter but a transverse diameter of 21 mm. The posterior root is, therefore, about twice as thick as the anterior one, and extends much further inward on the palate than the anterior one. It stands somewhat obliquely, as does also the part of the crown which surmounts it. Whether this posterior root is really divided so that the tooth has three roots in all cannot be positively determined from the specimen, which is filled with plaster at this point, but as the root measures 24 mm. at the end, it is quite likely that it is divided. Owing to the oblique position of the posterior root, the crown is somewhat triangular in horizontal section; the greater part of it, including all the cusps except the very small anterior basal one, is lacking. The antero-posterior length of the crown at the base is 48 mm.; the vertical length of the anterior root is 41 mm.

The first molar immediately follows the fourth premolar and is a somewhat smaller tooth. It is two-rooted, though the posterior root is somewhat twisted and thickened, and a horizontal section of the crown at the base shows a postero-internal enlargement, which gives it somewhat of a triangular form. The antero-posterior breadth of the crown at its base is 41 mm., and its greatest transverse diameter posteriorly, 15 mm. The middle portion of the crown is lacking, but the accessory cusps are nearly intact. These are of about the same size and shape as those of the first premolar, being convex both externally and internally and nearly vertical. There appear to have been two large anterior accessory cusps and a smaller basal one, and three posterior accessory cusps, together with a very small basal one, which probably represents part of the cingulum. The enamel is nearly smooth externally and only moderately rugose, with longitudinal lines, internally. At the middle of the tooth externally the distance between the base of the enamel and the margin of the maxilla is 12 mm., but internally the enamel extends farther up.

The concavity which follows the first molar and appears to represent the alveolus of the second molar is 26 mm. long. As it is undivided, this small tooth probably had the roots consolidated. It is not likely that any additional teeth followed this one.

The mandible which is included in this collection is so much broken that no detailed description of it seems desirable. The left side is represented by a piece 430 mm. long, extending from the second or third incisor to and somewhat beyond the posterior end of the tooth-row. The right side is represented only by fragments from the lower margin of

the ramus and a very small part of the symphysis (Plate 2, figure 6), with a canine, or incisor, tooth in position. This latter piece was figured in 1847 by Gibbes in his Plate 3, figure 2. Nearly all of it, however, has been lost since that date, and the tooth has been detached but is still preserved.

The left side of the mandible (Plate 3, figure 1) was also figured by Gibbes in 1847 in his Plate 3, figure 1. All the parts there shown are preserved, except the portion of a crown of a tooth which appears near the left-hand end of the figure. This figure is one-half natural size. Whether this mandible belongs to the same individual as the cranial fragments is uncertain, but if the proportions of the restoration are correct, it was about 680 mm. long when complete, or about one-half longer than at present. The first two-rooted tooth, or premolar, appears to be the one of which a portion of the crown is shown in Gibbes's figure. This is situated 104 mm. behind the anterior end of the jaw. In front of it, at the anterior end, are a portion of a simple alveolus, which should be that of the second incisor, and two other simple alveoli about 24 mm. in diameter, which should represent the canine and third incisor. These are 15 mm. apart, and the latter is 15 mm. from the first premolar. The latter tooth is succeeded by the second premolar, apparently without an interval. The upper end of the roots of the tooth measures 39 mm. antero-posteriorly. The location and number of teeth posterior to the second premolar cannot be determined from the specimen.

The symphysis is about 152 mm. long, as indicated by the flat internal surface of the left side of the jaw, and was probably but little prolonged anteriorly when complete. It ends posteriorly about opposite the second premolar, as in *Prozeuglodon*.

Of the atlas which accompanies the skull-fragments, little more than the lower half remains (Plate 2, figure 13). It is comparatively slender. The anterior articular facets are strongly declined. They are separated from the posterior facets by a ridge. The posterior facets are oblique rather than vertical. The inferior lateral process (broken) is thick at the base and compressed. It is only moderately directed downward and backward. The vertebrarterial foramen is large and is in line with the outer margin of the anterior articular facet. The following measurements were taken from the fragment:—Breadth between outer margins of anterior articular facets, 104 mm.; greatest thickness of atlas, 33; least thickness in median line, 24; breadth of inferior transverse process at base, 25.

The teeth figured by Gibbes in 1847 in Plate 2, figure 1 (two views),

and Plate 4, figure 3 (two views), are both in the collection (Plate 2, figures 7 and 8). The peculiar form of the crown of the former tooth is due to the fact that the upper half has been restored in wax and not properly shaped. The enamel is much rougher at the base than is indicated in Gibbes's figure. The other tooth is at present much broken. All the teeth, as Gibbes remarked, are hollow and filled with green sand.

None of the caudal vertebrae mentioned by Gibbes accompanied the other bones. The small ones figured by him in 1847 in his Plate 2, figures 4 and 5, might belong to the present species, but they are from too near the end of the tail to present any very strongly marked characters. They give a little support to the view that *Dorudon serratus* is a form with relatively short vertebrae like *Z. brachyspondylus minor*, instead of long vertebrae like *B. cetoides*.

For the comparison of *Dorudon* with other American zeuglodonts, I have had the use of the nearly complete skeletons of *Basilosaurus cetoides* and *Z. brachyspondylus minor*, collected by Professor Charles Schuchert in Alabama, and now in the National Museum, and a cast of the type skull of *Z. brachyspondylus minor* Stromer,¹ in Teyler's Museum, in Haarlem, which was sent to the National Museum for my use by the director, Professor E. Dubois.

The large species *B. cetoides* (or *macrospodylus*) is, I think, sufficiently differentiated from the others by its excessively elongated lumbar vertebrae and extremely thick epiphyses to be regarded as the representative of a separate genus. Its scientific name is properly *Basilosaurus cetoides* (Owen). Several Old World species have been associated with it under the synonymic generic name *Zeuglodon*, but *Z. isis* Andrews is the only one, apparently, which has elongated vertebrae. The dental formula of *Basilosaurus* was not given by Müller, and cannot be worked out fully from the material in the National Museum. The formula for the lower jaw, however, appears to be C. 3, I. 1, PM. 4, M. 3. The formula given by Andrews for *Zeuglodon* is, i. $\frac{3}{3}$; c. $\frac{1}{1}$; pm. $\frac{4}{4}$; m. $\frac{2 \text{ or } 3}{3}$,² but as this is based on, or at least includes, species with short lumbar vertebrae, it cannot be considered as necessarily correct for *Basilosaurus*, though the difference, if any, will doubtless prove slight when the dentition of the latter becomes fully known.

In *Basilosaurus cetoides* the atlas is thick and the posterior articular

¹ "Der Kleine Zeuglodon" of Müller.

² A descriptive catalogue of the Tertiary Vertebrata of the Fayûm, Egypt. 1906, p. 236.

surface vertical. The anterior and posterior articular facets are separated from each other by a very broad, flat surface. The vertebrarterial canal is not sunk into the side of the vertebra, but is about in line with the outer edges of the articular facets. The inferior lateral process is not strongly inclined backward. The upper surface of the premaxillae is flat, but the nasal branch strongly bent upward. The first upper premolar is small.

On comparing the type of *Dorudon serratus* Gibbes, with the type of *Zeuglodon brachyspondylus minor*, and the small zeuglodont from Alabama in the National Museum, I find that the Alabama specimen agrees with *Z. brachyspondylus minor*, and without doubt represents that form. *Dorudon serratus*, on the other hand, although of the same size, presents numerous differences. These are best seen in the following parallel columns:

| <i>Dorudon serratus.</i> | <i>Zeuglodon brachyspondylus minor.</i> |
|--|--|
| 1. Incisors smaller. | 1. Incisors larger. |
| 2. Incisors differently spaced from those of <i>Z. b. m.</i> | 2. Incisors differently spaced from those of <i>D. s.</i> |
| 3. Nasals vaulted. | 3. Nasals flat. |
| 4. Premaxillae broad and convex on top. | 4. Premaxillae rather narrow and flat on top. |
| 5. Premaxillae deep and flat on the sides. | 5. Premaxillae not so deep, and convex on the sides. |
| 6. Proximal end of nasal branch of premaxillae not strongly bent up. | 6. Proximal end of nasal branch of premaxillae strongly bent up. |
| 7. Atlas comparatively thin. | 7. Atlas thick. |
| 8. Outer expanded portion of posterior articular facets of atlas oblique. | 8. Outer expanded portion of posterior articular facets of atlas vertical. |
| 9. Vertebrarterial canals nearly in line with outer ends of articular facets. | 9. Vertebrarterial canal much within the line of the articular facets. |
| 10. Anterior and posterior articular facets of atlas separated above by a narrow flat surface. | 10. Anterior and posterior articular facets of atlas separated above by a broad concave surface. |
| 11. Inferior lateral process of atlas but little inclined backward. | 11. Inferior lateral process of atlas much inclined backward. |

Although some of the foregoing characters are doubtless to be regarded as specific, I think that, taken together, they afford sufficient

warrant for maintaining *Dorudon* as a separate genus, at least until more material representing *D. serratus* has been collected. As *Basilosaurus cetoides* is also, I think, to be considered distinct, on account of its excessively long lumbar vertebrae and very thick epiphyses, the form *brachyspondylus minor* appears to require a new generic appellation. I would propose the name ZYGORHIZA, and would assign to the genus the characters given in the foregoing column, under *Z. brachyspondylus minor*. This subspecies is the type of the genus.

The upper molars of *Z. brachyspondylus minor* are smaller than those of *D. serratus*, the anteorbital region is differently shaped, and the occipital crest is much higher. The last-mentioned character may, however, be due to difference in age or sex.

The dental formula of *Z. brachyspondylus minor* cannot be positively determined from the material at hand. For the lower jaw, however, it appears to be I. 3, C. 1, PM. 4, M. 3. The number of teeth is less important among the zeuglodonts than their form, as the difference in the various genera is not more than one molar tooth above and below. The divergence of the roots of the premolar and molar teeth, which is mentioned by Dames as a distinguishing character of *Dorudon*, appears to me of no great value, as the roots of the lower premolars of *Z. brachyspondylus*, at least, show a considerable divergence. The size and shape of the accessory cusps of the molars and premolars of *D. serratus* are not very different from those of *Z. brachyspondylus*. In Gibbes's figures of *Dorudon*, they are too nearly erect and somewhat exaggerated in size.